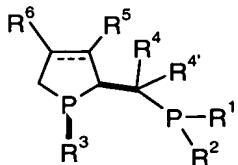


Claims

1. A phosphine compound of the formula I



I

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is an optional double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I.

2. The compound of formula I according to claim 1 wherein

R¹ and R² are the same and are alkyl, aryl, cycloalkyl or heteroaryl, said alkyl, aryl, cycloalkyl or heteroaryl may be substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl or aryl;

R^{4'} and R⁴ are hydrogen;
R⁵ and R⁶ are independently of each other hydrogen, C₁-C₃-alkyl or phenyl;
the dotted line is absent;
R⁷ is alkyl, aryl or NR⁸R^{8'}; and
R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl;
the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I.

3. The compound of formula I according to claim 1, wherein

R¹ and R² are the same and are aryl;
R³ is *tert*.-butyl or phenyl;
R^{4'} and R⁴ are the same and are hydrogen;
R⁵ and R⁶ are hydrogen; and the dotted line is absent.

4. The compound of formula I according to claim 1, wherein

R¹ and R² are the same and are alkyl;
R³ is *tert*.-butyl or phenyl;
R^{4'} and R⁴ are the same and are hydrogen;
R⁵ and R⁶ are hydrogen; and the dotted line is absent.

5. The compound of formula I according to claim 1, wherein

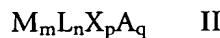
R¹ and R² are the same and are cycloalkyl;
R³ is *tert*.-butyl or phenyl;
R^{4'} and R⁴ are the same and are hydrogen;
R⁵ and R⁶ are hydrogen; and the dotted line is absent.

6. The compound of formula I according to claim 1, wherein

R¹ and R² are the same and are heteroaryl;
R³ is *tert*.-butyl or phenyl;
R^{4'} and R⁴ are the same and are hydrogen;
R⁵ and R⁶ are hydrogen; and the dotted line is absent.

7. The compound of formula I, wherein R¹ and R² are the same and are phenyl, R³ is phenyl and R⁴, R^{4'}, R⁵ and R⁶ are hydrogen.

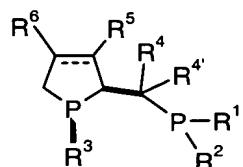
8. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I, wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is an optional double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I;

X is a coordinating anion,

m, n and p are each 1, and

q is 0, if M is Rh.

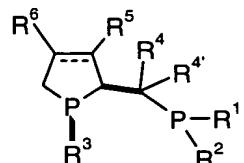
9. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I, wherein

R^1 and R^2 are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, $-SO_2-$, R^7 , $-SO_3^-$, $-CO-NR^8R^{8'}$, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R^3 is alkyl, cycloalkyl, aryl or heteroaryl;

R^4 and R^4' is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^4 and R^4' together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is an optional double bond;

R^5 and R^6 are independently of each other hydrogen, alkyl or aryl;

R^7 is alkyl, aryl or $NR^8R^{8'}$; and

R^8 and $R^{8'}$ are independently of each other hydrogen, alkyl or aryl; the substituents R^3 on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is acyloxy,

m and n are each 1,

p is 2, and

q is 0, if M is Ru.

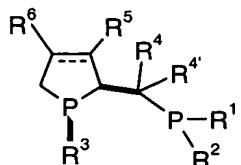
10. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is Cl,

m and n are each 2,

p is 4,

q is 1, and

A is triethylamine, if M is Ru.

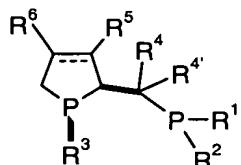
11. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I, wherein

R^1 and R^2 are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, $-SO_2-$, R^7 , $-SO_3^-$, $-CO-NR^8R^{8'}$, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R^3 is alkyl, cycloalkyl, aryl or heteroaryl;

R^4 and R^4' is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^4 and R^4' together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R^5 and R^6 are independently of each other hydrogen, alkyl or aryl;

R^7 is alkyl, aryl or $NR^8R^{8'}$; and

R^8 and $R^{8'}$ are independently of each other hydrogen, alkyl or aryl; the substituents R^3 on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

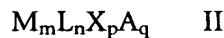
X is a π -methallyl group,

m and n are each 1,

p is 2, and

q is 0, if M is Ru.

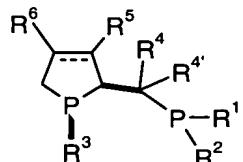
12. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I, wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

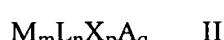
R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is a coordinating anion,

m, n and p are each 1, and

q is 0, if M is Ir.

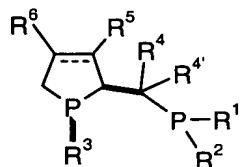
13. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I, wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is Cl,

m and n are each 1,

p is 2, and

q is 0, if M is Pd.

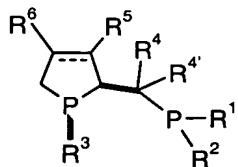
14. A transition metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R⁴' are independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R⁴' together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is Cl, Br or I,

m and n are each 1,

p is 2, and

q is 0, if M is Ni.

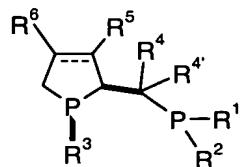
15. A transition metal complex of formula



wherein

M is Rh,

L is the diphosphine compound the formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is a coordinating anion,

m, n and p are each 1, and

q is 0.

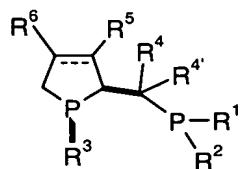
16. A metal complex of formula



wherein

M is a transition metal,

L is the diphosphine compound of the formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C₂ atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is a diene ligand,

D is a non-coordinating anion,

m, n, p and r are each 1, and

q is 0, if M is Rh.

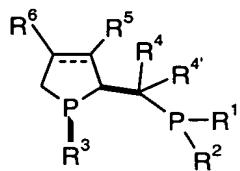
17. A metal complex of formula



wherein

M is for a transition metal,

L is the diphosphine compound of formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is an olefinic ligand,

D is a non-coordinating anion,

m, n and r are each 1,

p is 2 and

q is 0, if M is Rh.

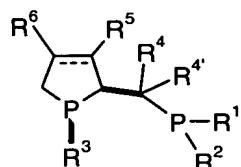
18. A metal complex of formula



wherein

M is a transition metal,

L is the diphosphine compound of the formula I



cis I, wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

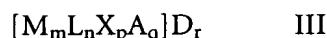
X is Cl, Br or I,

A is benzene or p-cymene,

D is Cl, Br or I, and

m, n, p, q and r are each 1, if M is Ru.

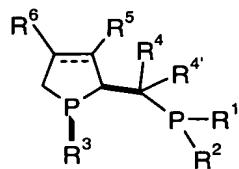
19. A metal complex of formula



wherein

M is for a transition metal,

L is for the diphosphine compound of formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

D is a non-coordinating anion,

m and n are each 1,

p and q are each 0, and

r is 2, if M is Ru.

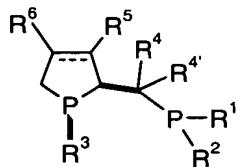
20. A metal complex of formula



wherein

M is for a transition metal,

L is for the diphosphine compound of the formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

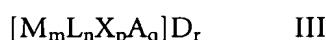
X is a diene ligand.,

D is a non-coordinating anion,

m, n, p and r are each 1, and

q is 0, if M is Ir.

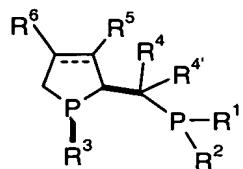
21. A metal complex of formula



wherein

M is for a transition metal,

L is the diphosphine compound of the formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is an olefinic ligand,

D is a non-coordinating anion,

m, p and r are each 1,

n is 2 and

q is 0, if M is Ir.

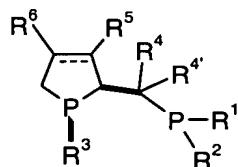
22. A metal complex of formula



wherein

M is a transition metal,

L is the diphosphine compound of formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I.

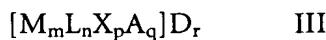
X is a π -allyl group,

D is a non-coordinating anion,

m, n, p and r are each 1, and

q is 0, if M is Pd.

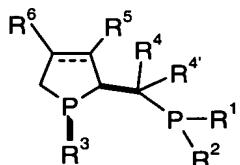
23. A metal complex of formula



wherein

M is for Rh,

L is for the diphosphine compound of the formula I



cis

I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R^{4'} and R⁴ is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^{4'} and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I, and

wherein

X is a diene ligand,

D is a non-coordinating anion,

m, n, p and r are each 1, and

q is 0.

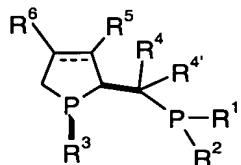
24. A metal complex of formula



wherein

M is for Rh,

L is for the diphosphine compound of the formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R⁴' are independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴' and R⁴ together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is an olefinic ligand,

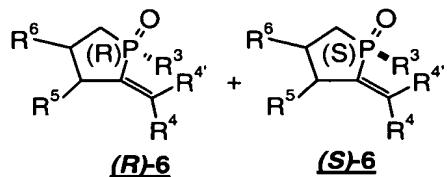
D is a non-coordinating anion,

m, n and r are each 1,

p is 2 and

q is 0.

25. An optical active compound of formula 6



wherein R^4' and R^4 is independently of each other hydrogen, alkyl or optionally substituted aryl; or

$R^{4'}$ and R^4 together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is absent or is present and forms a double bond;

R^5 and R^6 are independently of each other hydrogen, alkyl or aryl.

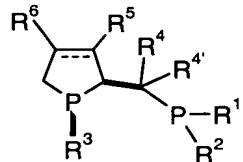
26. A process for the asymmetric hydrogenation of a prochiral olefinic or ketonic compound wherein the reaction is carried out in presence of metal complex of formula II



wherein

M is a transition metal,

L is the diphosphine compound of the formula I



cis

I,

wherein

R^1 and R^2 are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, $-SO_2-$, $-SO_3^-$, $-CO-NR^8R^{8'}$, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R^3 is alkyl, cycloalkyl, aryl or heteroaryl;

R^4 and R^4 is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R^4 and R^4' together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R^5 and R^6 are independently of each other hydrogen, alkyl or aryl;

R^7 is alkyl, aryl or $NR^8R^{8'}$; and

R^8 and $R^{8'}$ are independently of each other hydrogen, alkyl or aryl;

the substituents R^3 on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is a coordinating anion,

m, n and p are each 1, and

q is 0, if M is Rh, or

wherein

M is a transition metal,

L is the diphosphine compound of formula I,

X is acyloxy,

m and n are each 1,

p is 2, and

q is 0, if M is Ru, or

wherein

M is a transition metal,

L is the diphosphine compound of formula I,

X is Cl,

m and n are each 2,

p is 4,

q is 1, and

A is triethylamine, if M is Ru, or

wherein

M is a transition metal,

L is the diphosphine compound of formula I,

X is a π -methallyl group,

m and n are each 1,
p is 2, and
q is 0, if M is Ru, or

wherein

M is a transition metal,
L is the diphosphine compound of formula I,
X is a coordinating anion,
m, n and p are each 1, and
q is 0, if M is Ir, or

wherein

M is a transition metal,
L is the diphosphine compound of formula I,
X is Cl,
m and n are each 1,
p is 2, and
q is 0, if M is Pd, or

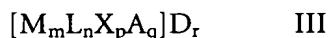
wherein

M is a transition metal,
L is the diphosphine compound of formula I,
X is Cl, Br or I,
m and n are each 1,
p is 2, and
q is 0, if M is Ni, or

wherein

M is Rh,
L is the diphosphine compound of formula I;
X is a coordinating anion,
m, n and p are each 1, and
q is 0.

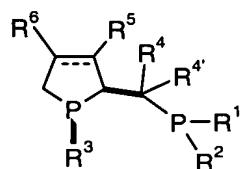
27. A process for the asymmetric hydrogenation of a prochiral olefinic or ketonic compound wherein the reaction is carried out in presence of metal complex of formula III



wherein

M is a transition metal,

L is the diphosphine compound of the formula I



cis I,

wherein

R¹ and R² are independently of each other unsubstituted alkyl, aryl, cycloalkyl or heteroaryl, or alkyl, aryl, cycloalkyl or heteroaryl each of which independently is substituted by alkyl, alkoxy, halogen, hydroxy, amino, mono- or dialkylamino, aryl, -SO₂-R⁷, -SO₃⁻, -CO-NR⁸R^{8'}, carboxy, alkoxy carbonyl, trialkylsilyl, diarylalkylsilyl, dialkylarylsilyl or triarylsilyl;

R³ is alkyl, cycloalkyl, aryl or heteroaryl;

R⁴ and R^{4'} is independently of each other hydrogen, alkyl or optionally substituted aryl; or

R⁴ and R^{4'} together, with the C-atom they are attached, form a 3-8-membered carbocyclic ring;

dotted line is optionally a double bond;

R⁵ and R⁶ are independently of each other hydrogen, alkyl or aryl;

R⁷ is alkyl, aryl or NR⁸R^{8'}; and

R⁸ and R^{8'} are independently of each other hydrogen, alkyl or aryl; the substituents R³ on the phospholane phosphorus atom and the substituent on the C2 atom of the phospholane ring are in *cis* relation to each other as indicated by the bold bonds in formula I,

X is a diene ligand,

D is a non-coordinating anion,

m, n, p and r are each 1, and

q is 0, if M is Rh, or

wherein

M is for a transition metal,
L is the diphosphine compound of formula I,
X is an olefinic ligand,
D is a non-coordinating anion,
m, n and r are each 1,
p is 2 and
q is 0, if M is Rh, or

wherein

M is a transition metal,
L is the diphosphine compound of formula I;
X is Cl, Br or I,
A is benzene or p-cymene,
D is Cl, Br or I, and
m, n, p, q and r are each 1, if M is Ru, or

wherein

M is for a transition metal,
L is for the diphosphine compound of formula I,
D is a non-coordinating anion,
m and n are each 1,
p and q are each 0, and
r is 2, if M is Ru, or

wherein

M is for a transition metal,
L is for the diphosphine compound of formula I,
X is a diene ligand,,
D is a non-coordinating anion,
m, n, p and r are each 1, and
q is 0, if M is Ir, or

wherein

M is for a transition metal,
L is the diphosphine compound of formula I,
X is an olefinic ligand,
D is a non-coordinating anion,
m, p and r are each 1,
n is 2 and
q is 0, if M is Ir, or

wherein

M is a transition metal,
L is the diphosphine compound of formula I;
X is a π -allyl group,
D is a non-coordinating anion,
m, n, p and r are each 1, and
q is 0, if M is Pd, or

wherein

M is for Rh,
L is for the diphosphine compound of formula I,
X is a diene ligand,
D is a non-coordinating anion,
m, n, p and r are each 1, and
q is 0, or

wherein

M is for Rh,
L is for the diphosphine compound of formula I,
X is an olefinic ligand,
D is a non-coordinating anion,
m, n and r are each 1,
p is 2 and
q is 0.